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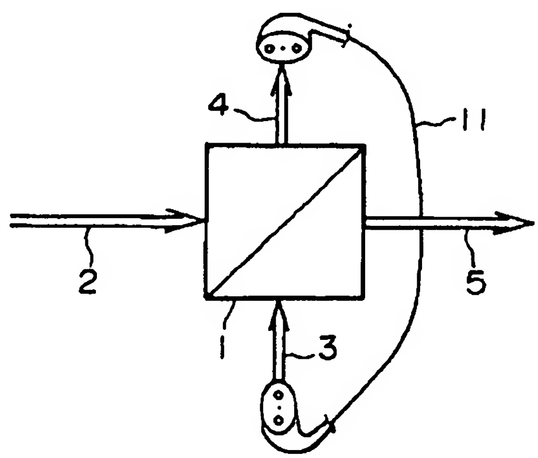
(54)【発明の名称】　デポラライザ

(57)【要約】

【目的】　使用光ファイバの長さを従来のタイプにおいて使用するファイバの1/2としたデポラライザ。

【構成】　偏光ビームスプリッタによって分離された2つの偏光のうち、一つが遅延線路として使用される偏波保持光ファイバからなる光ファイバループを通り、その偏光軸を90°相当回転し、偏光軸を入れ換え、上記偏波保持光ファイバを2回通過した後、他方の偏光に合流するようにされているデポラライザ。



【特許請求の範囲】

【請求項1】　第1および第2の入射端と、第1および第2の出射端を有し、第1の入射端から入射された偏光をS偏波成分とP偏波成分とに分離してそれぞれ第1の出射端および第2の出射端から出射する偏光ビームスプリッタと、

この偏光ビームスプリッタの第1または第2出射端に一端が接続され、他端がその偏光軸を90°相当回転させて上記第2の入射端に接続され、遅延線路として機能する偏波保持光ファイバからなる光ファイバループを有するデポラライザ。

【請求項2】　第1および第2の入射端と、第1および第2の出射端を有し、各入射端から入射された偏光を高群速度軸成分と低群速度軸成分とに分離し、各々異なる出射端へ出射する偏波保持光ファイバからなる光ファイバ型偏光ビームスプリッタと、

この光ファイバ型偏光ビームスプリッタの一方の出射端に一端が接続され、他端が一方の入射端に接続されて遅延線路として機能するとともに上記光ファイバ型偏光ビームスプリッタとともに光ファイバループを構成する偏波保持光ファイバとからなり、

上記光ファイバループには、偏光軸を90°相当回転する機能を持つ部分が存在するデポラライザ。

【発明の詳細な説明】

【0001】

【産業上の利用分野】この発明は、光の偏光を解消し、無偏光とするためのデポラライザにおいて、使用する偏波保持光ファイバの長さを、従来の同様なタイプのものの1/2としたデポラライザに関する。

【0002】

【従来の技術】一般に無偏光状態でのコヒーレンス行列は

【数1】

$$\begin{vmatrix} 0 & 1 \\ 1 & 0 \end{vmatrix}$$

と表わされる（土井、「偏光と結晶光学」共出出版）。この行列の意味は、2偏光軸の各成分が①パワーが等しく、②干渉しないと言い換え得る。上記①のパワーが等しい条件に関しては、入射偏光光の偏光角を調整して入射したり、直線偏光光を軸に対して45°の角度で入射する等の方法によって容易に実現できる。また後述の干渉性を失わせる装置を2個以上用い、その間を45°の軸角度で接続することにより、例えばリオタイプデポラライザ（JOURNAL OF LIGHT WAVETECHNOLOGY Vol LT-1 No.3 SEPTEMBER 1983）のように任意の入射角に対応可能である。

【0003】②の干渉しないという条件に関しては、2偏光成分間に時間的なずれを生じさせ、そのずれを入射光のコヒーレンス時間以上とすることにより、干渉性を失わせる。図5は、従来の装置の説明図で、図中符号1は第1の入射端2、第2の入射端3、第1の出射端4、第2の出射端5が設けられた偏光ビームスプリッタである。第1の入射端2から入射された偏光は、第2の出射端5に直進するP偏光成分（以下Pという）、分離されて第1の出射端4に導かれるS偏光成分（以下Sという）よりなる。第1の入射端2から入射したP，SのうちPは直進してただちに第2の出射端5から出射され、Sは分離された後、第1の出射端4から偏波保持光ファイバ6を通り再び偏光ビームスプリッタ1に入り反射され、直進するPと共に第2出射端5より出射される。このように偏光ビームスプリッタ1によってS，Pに分離し、Sのみを遅延線路となる偏波保持光ファイバ6を通過させることにより両偏光間の光路差をコヒーレント長（コヒーレント時間×光速）以上とすることにより干渉性を失わせている。

【0004】ここでコヒーレンス長ΔLは、光速をC、光源のスペクトルの半値幅をΔｆとすると、おおむねC／Δｆとなる。例えば半値幅1MHｚ程度の光源（例えばDFBレーザ等）では、コヒーレント長は100ｍのオーダとなる。この光路差を上述のリオタイプデポラライザのように光ファイバの複屈折のみで得ようとすると、現在の偏波保持光ファイバの平均的な複屈折値を5×10^{-4}とすれば、数100ｋｍのオーダとなり、光ファイバのクロストークや損失などにより、特性が劣化してしまい、実用的でない。

【0005】

【発明が解決しようとする課題】ところで、従来の偏波ビームスプリッタを用いるものでも、数100ｍオーダとなると、

（ａ）偏波保持光ファイバは通常の光ファイバに比べ高価で、コスト高となる。

（ｂ）クロストークの影響が出てくるため、光ファイバの被覆や光ファイバの固定方法等に配慮し、クロストークを悪化させるような外部応力を加えないようにする必要が生ずる。

（ｃ）光ファイバ中の損失が無視できなくなる。

等の欠点が表われる。したがって、偏波保持光ファイバの長さは、短い方がよいが、コヒーレント長を確保するためには短くできなかった。

【0006】本発明は上記の事情に鑑みてなされたもので、光の偏光を解消し、無偏光とするためのデポラライザにおいて、使用するファイバ長が従来の同様なタイプのものに対して1/2 と短縮することができるデポラライザを提供することを目的とする。

【0007】

【課題を解決するための手段】本発明に係るデポラライザにおいては、第1および第2の入射端と、第1および第2の出射端を有し、第1の入射端から入射された偏光をS偏波成分とP偏波成分とに分離してそれぞれ第1の

出射端および第２の出射端から出射する偏光ビームスプリッタと、この偏光ビームスプリッタの第１または第２出射端に一端が接続され、他端がその偏光軸を９０゜回転させて上記第２の入射端に接続され、遅延線路として機能する偏波保持光ファイバとからなることを問題解決の手段とした。あるいは、第１および第２の入射端と、第１および第２の出射端を有し、各入射端から入射された偏光を高群速度軸成分と低群速度軸成分とに分離し、各々異なる出射端へ出射する偏波保持光ファイバからなる光ファイバ型偏光ビームスプリッタと、この光ファイバ型偏光ビームスプリッタの一方の出射端に一端が接続され、他端が一方の入射端に接続されて遅延線路として機能するとともに上記光ファイバ型偏光ビームスプリッタとともに光ファイバループを構成する偏波保持光ファイバとからなり、上記光ファイバループには、偏光軸を９０゜相当回転する機能を持つ部分が存在するデポラライザでもよい。

【０００８】

【実施例】図１は、請求項１記載のデポラライザの一例を示すもので、図５に示したものと同一構成部分には同一符号を付してその説明を省略する。偏光ビームスプリッタ１に入る２つの偏波、Ｐ偏波およびＳ偏波が第１の入射端２から入射すると、直進するＰはただちに第２出射端５から出射され、Ｓは分離された後第１出射端４から光ファイバループをなす偏波保持光ファイバ１１に入射され、光ファイバ中を伝搬して９０゜相当回転し、Ｐとして第２の入射端３から偏光ビームスプリッタ１に入射される。本発明における９０゜相当とは、回転角度が９０゜以外に９０゜＋ｎ×１８０゜（但しｎは整数）であれば同様な効果が得られるためであり、このような効果を得られる角度を総称するものである。Ｐは偏光ビームスプリッタ１中を直進するので、第１の入射端３から再び偏波保持光ファイバ１１に入射され伝搬後、９０゜

相当回転し、Ｓとして出射され、偏光ビームスプリッタ１に入射される。このＳは、先にファイバを通過しないもともとのＰと同じ第２の出射端５の方向に出射され、この第２の出射端５で両偏波Ｓ，Ｐが合波される。

【０００９】上述の最初に偏光ビームスプリッタ１に入射されたＳは、偏波保持光ファイバ１１中を２回通過した後に出射されるが、その際最初入射されたＰに対して偏波保持光ファイバの長さの２倍の光路差をもって出射される。これにより光ファイバ長は必要な行路差（コヒーレント長）の半分の長さでよいことになる。

【００１０】図１の偏光ビームスプリッタ１を誘電体膜とプリズムによって構成するとともに、偏波保持光ファイバ１１として市販の低損失で偏波保存特性のよいパンダファイバ５０ｍで構成したデポラライザを用い、コヒーレント長１００ｍのＤＦＢレーザを入射し、偏光度０．０１を得た。

【００１１】また図２は、請求項１に記載のデポラライザの他の実施例を示すもので、図１と同一部分には同一符号が付してある。図２においては、出射側と入射側の光軸が異なるが、偏波保持光ファイバ１１の偏波軸を９０゜相当回転させることにより、Ｐは偏波保持光ファイバ中を２回通過した後出射される。この構成においても、図１のものと同様の偏光度が得られた。

【００１２】次に、請求項２に記載の光ファイバ型偏光ビームスプリッタ（以下、ファイバ型スプリッタと言う。）を用いたデポラライザについて説明する。ファイバ型スプリッタには、以下の表１に示す３種類が考えられるが、ここでのデポラライザにはすべてのタイプのものが使用可能で、これらのすべてのタイプに共通に、光ファイバ中から光を空間に出さずにすむので、レンズ系等が不要となるなどの利点がある。

【００１３】

【表１】

	入射端	成　分	出射端	成　分
1	第1	x	クロス端	x
	第1	y	スルー端	y
	第2	x	クロス端	x
	第2	y	スルー端	y
2	第1	x	スルー端	x
	第1	y	クロス端	y
	第2	x	スルー端	x
	第2	y	クロス端	y
3	第1	x	クロス端	y
	第1	y	スルー端	y
	第2	x	スルー端	x
	第2	y	クロス端	x

表１中の成分ｘとは、低群速度軸（ｘ軸）の成分と言い、成分ｙとは高群速度軸（ｙ軸）の成分を言う。

【００１４】図３に示す例は、表１における第１のファイバ型スプリッタ２１を用いたもので、第１の入射端２４に対するスルー端は第１の出射端２６、クロス端は第２の出射端２７であり、第２の入射端２５に対するスルー端は第２の出射端２７、クロス端は第１の出射端２６となる。第１の入射端２４に入射される偏光のｙ成分はすぐに第１の出射端２６にｙとして出射されるが、第１の入射端２４に入射されるｘ成分は第２の出射端２７にｘとして出射され、偏波保持光ファイバからなる光ファイバループ２３を伝搬し、該ループ２３の任意の点で偏光を９０°相当回転する接続点２２により、ｙとして第２の入射端２５に入射される。第２の入射端２５に入射したこのｙは、第２の出射端２７にｙとして出射され、再び光ファイバループ２３を伝搬し、第２の入射端２５にｘとして入射する。第２の入射端２５に入射したｘは第１の出射端２６からｘとして出射される。

【００１５】以上のように第１の入射端２４から入射するｘ成分は、接続点２２により９０°相当回転させられることにより光ファイバループ２３を２回通った後に出射され、偏光ビームスプリッタを使用した場合と同様の効果が得られる（光ファイバループ長５０ｍ，コヒーレント長１００ｍのＤＥＢレーザ入射）。

【００１６】図４に示した例では、第１の入射端２４のスルー端は、第２の出射端２７で、クロス端は第１の出射端２６であり、第２の入射端２５のスルー端は第１の出射端２６で、クロス端は第２の出射端２７となる。この例では第１の入射端２４に入射されるｙ成分が光ファイバループ２３に伝搬され、遅延を受け出射される。但し、この場合第１の入射端２４と第１の出射端２６の間で複屈折の効果によりｘ成分が遅延するため、ループ２３を構成する偏波保持光ファイバの長さによっては効果が低減するおそれがあるが、複屈折による効果は偏波保持ファイバ長に対して10^{-3}～10^{-4}のオーダであるので、ほとんど問題とはならない。入、出射ファイバ長約１ｍのとき、先の例のデポラライザとほぼ同じ結果を得た。

【００１７】他の実施例として、図３の構成でファイバ型スプリッタ２１を表１の第３のタイプとしたものについて説明する。第１の入射端２４に入るｙはすぐに第１の出射端２６にｙとして出射されるが、第１の入射端２４から入射したｘは、第２の出射端２７にｙとして出射され、光ファイバループ２３を伝搬し、接続点２２において９０°相当回転してｘとして第２の入射端２５に入射される。第２の入射端２５に入射されたｘは、第２の出射端２７にｘとして出射されるが再び光ファイバループ２３を伝搬し、９０°相当回転して第２の入射端２５にｙとして入射する。第２の入射端２５に入射したｙは、第１の出射端２６からｘとして出射される。この例のものにおいても先の例と同等の結果が得られた。

【００１８】さらに、他の実施例として、図５に示す構成で、ファイバ型スプリッタを表１の第３のタイプとした場合について説明する。各入出射端におけるスルー端およびクロス端の関係は、図４の例と同じである。第１の入射端２４に入射されるｘ成分は、すぐに第１の出射端２６にｙとして出射されるが、第１の入射端２４に入るｙは、第２の出射端２７にｙとして出射され、光ファイバループ２３を伝搬し、第２の入射端２５にｙとして入射される。この例では光ファイバループ２３には、特に偏光を９０°相当回転させる接続点は設けられておらず、この９０°相当回転させる機能は、ファイバ型スプリッタ２１のクロス端出射で偏光が９０°回転することを利用するようになっている。第２の入射端２５のｙ

は、第2の出射端27のxとして出射され、再び光ファイバループ23を伝搬し、第2の入射端25にxとして入射される。第2の入射端25のxは、第1の出射端26にxとして出射される。この例でも、先の例と同じ結果が得られた。

【0019】（比較例1）従来の図6の装置を用い、光ファイバ長50mで、コヒーレント長100mのDFBレーザを入射したところ、コヒーレントな成分が残留しており、偏光度0．2程度までしか得られなかった。

【0020】（比較例2）比較例1と同じ装置により、光ファイバ長100mで、コヒーレント長100mのDFBレーザを入射したところ、偏光度0．02程度までしか得られなかった。前記実施例、比較例はいずれも入射光強度は各軸とも等しくなるように、入射光の偏光方向を調整しながら行なったものである。

【0021】

【発明の効果】以上説明したように、遅延路線として用いる偏波保持光ファイバからなる光ファイバループに、偏光を90°相当回転する機能をもたせ、偏波軸を入れ換えることにより、入射光の偏光成分のうち一方の成分の光のみが遅延線路を2回通過するようにしたため、遅延線路長が従来の半分にできる。したがってコストの低減が可能となり、クロストークの悪化による特性の低下

が軽減され、またファイバ伝搬による損失も低減可能で、全体として低損失化ができる。

【図面の簡単な説明】

【図1】　偏光ビームスプリッタを用いた本発明に係るデポラライザの一実施例を示す図である。

【図2】　偏光ビームスプリッタを用いた他の例を示す図である。

【図3】　カップラ型ビームスプリッタを用いた本発明の一実施例を示す図である。

【図4】　光ファイバ型ビームスプリッタを用いた他の例を示す図である。

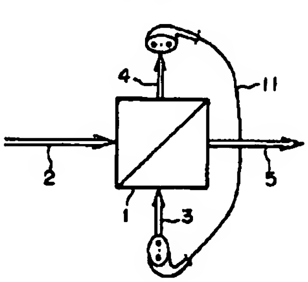
【図5】　光ファイバ型偏光ビームスプリッタを用いた他の例を示す図である。

【図6】　従来のデポラライザを示す図である。

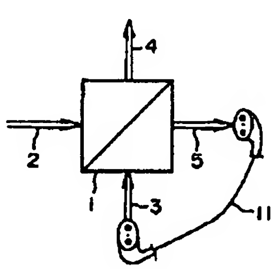
【符号の説明】

1…偏光ビームスプリッタ、2…第1の入射端、3…第2の入射端、4…第1の出射端、5…第2の出射端、6…偏波保持光ファイバ、11…90°相当回転させる偏波保持光ファイバ、21…光ファイバカップラ型偏光ビームスプリッタ（カップラ型スプリッタ）、22…接続点、23…光ファイバループ、24…第1の入射端、25…第2の入射端、26…第1の出射端、27…第2の出射端、P，S…偏波成分、x，y…偏波成分

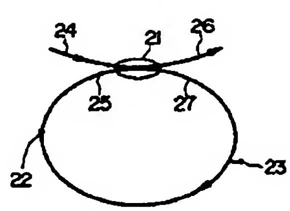
【図1】



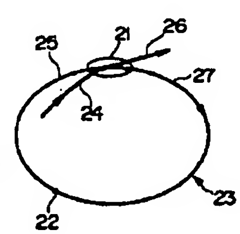
【図2】



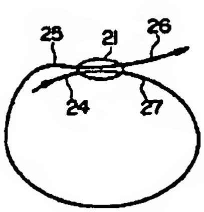
【図3】



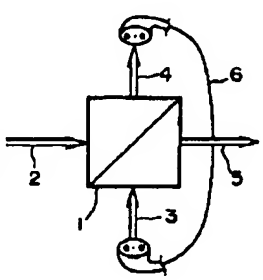
【図4】



【図5】



【図6】



DEPOLARIZER

Patent Number: JP6051243

Publication date: 1994-02-25

Inventor(s): SAWADA MINORU; others: 01

Applicant(s):: FUJIKURA LTD

Requested Patent: JP6051243

Application Number: JP19920205721 19920731

Priority Number(s):

IPC Classification: G02B27/28 ; G02B5/30

EC Classification:

Equivalents:

Abstract

PURPOSE:To provide a depolarizer in which the length of optical fiber used is half of that of fiber used in conventional types.

CONSTITUTION:In a depolarizer, of two rays 4, 5 of polarized light separated from each other by a polarizing beam splitter 2, one 4 is allowed to pass through an optical-fiber loop comprising a polarization maintaining optical fiber 11 used as a delay line, has its axis of polarization rotated by 90 degrees or so and switched to the other, passes through the polarization-holding optical fiber 11 twice, and recombines to the other polarized light 5.

CLAIMS

[Claim(s)]
[Claim 1] The polarization beam splitter which has the 1st and 2nd incidence edges and the 1st and 2nd outgoing-radiation edges, divides into S polarization component and P polarization component the polarization by which incidence was carried out from the 1st incidence edge, and carries out an outgoing radiation from the 1st outgoing-radiation edge and the 2nd outgoing-radiation edge, respectively, the [of this polarization beam splitter / the 1st or] -- the depolarizer which has the optical fiber loop which consists of a polarization hold optical fiber which an end is connected to 2 outgoing-radiation edge, and the other end makes rotate the polarization shaft by 90 degrees, is connected to the incidence edge of the above 2nd, and functions as delay line
[Claim 2] Have the 1st and 2nd incidence edges and the 1st and 2nd outgoing-radiation edges, and the polarization by which incidence was carried out from each incidence edge is divided into a high group-velocity shaft component and a low group-velocity shaft component. The optical fiber type polarization beam splitter which consists of a polarization hold optical fiber which carries out an outgoing radiation to a respectively different outgoing-radiation edge, An end is connected to one outgoing-radiation edge of this optical fiber type polarization beam splitter. It consists of a polarization hold optical fiber which constitutes an optical fiber loop with the above-mentioned optical fiber type polarization beam splitter while it connects with one incidence edge and the other end functions as delay line. The depolarizer in which the fraction which has the function to rotate a polarization shaft by 90 degrees in the above-mentioned optical fiber loop exists.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention cancels polarization of light and relates to the depolarizer which set the length of the polarization hold optical fiber to use to one half of things same type [conventional] in the depolarizer for suppose-less polarizing.
[0002]
[Description of the Prior Art] Generally the coherence matrix in the status that it does not polarize is [Equation 1].

It is expressed (Doi, "polarization and crystal optics" paragenesis publication). It can be put in another way as each component of 2 polarization shaft having equal ** power, and not doing ** interference of the meaning of this matrix. About equal conditions, incidence of the polarization angle of incidence polarization light can be adjusted and carried out, or power of the above-mentioned ** can be easily realized by carrying out incidence at the angle of 45 degrees [centering around linearly polarized light light] etc. Moreover, it can correspond to arbitrary incident angles by connecting the meantime with the degree of axial angle of 45 degrees using two or more equipments which make the below-mentioned coherence lose like for example, a ********** depolarizer (JOURNAL OF LIGHT WAVETECHNOLOGY Vol LT-1 NO.3 SEPTEMBER 1983).
[0003] ** Produce a time gap between 2 polarization components, and make coherence lose about the conditions of not interfering, by carrying out the gap to more than the coherence time of an incident light. Drawing 5 is explanatory drawing of the conventional equipment, and the sign in drawing 1 is the polarization beam splitter in which the 1st incidence edge 2, the 2nd incidence edge 3, the 1st outgoing-radiation edge 4, and the 2nd outgoing-radiation edge 5 were established. The polarization by which incidence was carried out from the 1st incidence edge 2 consists of a P polarization component (henceforth P) which goes straight on at the 2nd outgoing-radiation edge 5, and an S polarization component (henceforth S) which is separated and is led to the 1st outgoing-radiation edge 4. Among P and S which carried out incidence from the 1st incidence edge 2, P goes straight on, an outgoing radiation is immediately carried out from the 2nd outgoing-radiation edge 5, after dissociating, from the 1st outgoing-radiation edge 4, it goes into a polarization beam splitter 1 again, and is reflected through the polarization hold optical fiber 6, and the outgoing radiation of the S is carried out from the 2nd outgoing-radiation edge 5 with P which goes straight on. Thus, a polarization beam splitter 1 separates into S and P, and

coherence is made to lose by carrying out the optical path difference during both polarization to more than coherent length (coherent time x velocity of light) by passing the polarization hold optical fiber 6 which serves as the delay line only in S.

[0004] Coherence-length deltaL will serve as C/delta f in general here, if half-value width of the spectrum of C and the light source is set to deltaf for the velocity of light. For example, in the with a half-value width [of about 1MHz] light sources (for example, DFB laser etc.), coherent length becomes 100m order. If it is going to acquire this optical path difference only by the birefringence of an optical fiber like an above-mentioned ********** depolarizer, it becomes 5x10-4, then several 100km order about the average birefringence value of the present polarization hold optical fiber, a property deteriorates by the cross talk of an optical fiber, loss, etc., and it is not practical.

[0005]

[Problem(s) to be Solved by the Invention] By the way, if the thing using the conventional polarization beam splitter also serves as several 100m order, compared with a usual optical fiber, (a) polarization hold optical fiber will be expensive, and will serve as cost quantity.

(b) In order that the influence of a cross talk may come out, the need of being made not to apply the external stress which worsens a cross talk in consideration of covering of an optical fiber, the fixed technique of an optical fiber, etc. arises.

(c) It becomes impossible to ignore the loss in an optical fiber.

The fault of a grade appears. Therefore, although the length of a polarization hold optical fiber had the shorter good one, in order to secure coherent length, it was not made short.

[0006] For this invention, the fiber length which uses it in the depolarizer for were made in view of the above-mentioned situation, cancel polarization of light, and suppose-less polarizing is one half to a thing same type [conventional]. It aims at offering the depolarizer which can be shortened.

[0007]

[Means for Solving the Problem] In the depolarizer concerning this invention The 1st and the 2nd incidence edge, The polarization beam splitter which has the 1st and 2nd outgoing-radiation edges, divides into S polarization component and P polarization component the polarization by which incidence was carried out from the 1st incidence edge, and carries out an outgoing radiation from the 1st outgoing-radiation edge and the 2nd outgoing-radiation edge, respectively, the of this polarization beam splitter / the 1st or] -- an end is connected to 2 outgoing-radiation edge, the other end rotates 90 degrees of the polarization shaft, and it connects with the incidence edge of the above 2nd, and made into the means of a problem solving to consist of a polarization hold optical fiber which functions as delay line Or it has the 1st and 2nd incidence edges and the 1st and 2nd outgoing-radiation edges. The optical fiber type polarization beam splitter which consists of a polarization hold optical fiber which carries out an outgoing radiation to the outgoing-radiation edge which divides into a high group-velocity shaft component and a low group-velocity shaft component the polarization by which incidence was carried out, and is respectively different from each incidence

edge, An end is connected to one outgoing-radiation edge of this optical fiber type polarization beam splitter. It consists of a polarization hold optical fiber which constitutes an optical fiber loop with the above-mentioned optical fiber type polarization beam splitter while it connects with one incidence edge and the other end functions as delay line. The depolarizer in which the fraction which has the function to rotate a polarization shaft by 90 degrees in the above-mentioned optical fiber loop exists is sufficient.

[0008]

[Example] Drawing 1 gives the same sign to the same component as what shows an example of a depolarizer according to claim 1, and was shown in drawing 5 , and omits the explanation. If two polarization, P polarization, and S polarization included in a polarization beam splitter 1 carry out incidence from the 1st incidence edge 2 The outgoing radiation of the P which goes straight on is immediately carried out from the 2nd outgoing-radiation edge 5, incidence of the S is carried out to the polarization hold optical fiber 11 which makes an optical fiber loop from the separated back 1st outgoing-radiation edge 4, it spreads the inside of an optical fiber, and rotates by 90 degrees, and incidence is carried out to a polarization beam splitter 1 from the 2nd incidence edge 3 as P. The angle which the amount of [in this invention] 90 degrees are because the same effect is acquired if angle of rotation is 90 degrees +nx180 degrees (however, n integer) in addition to 90 degrees, and can acquire such an effect is named generically. Since it goes the inside of a polarization beam splitter 1 straight on, after propagation, incidence is again carried out to the polarization hold optical fiber 11 from the 1st incidence edge 3, P rotates by 90 degrees, as S, the outgoing radiation of it is carried out and incidence is carried out to a polarization beam splitter 1. The outgoing radiation of this S is carried out in the orientation of the 2nd same outgoing-radiation edge 5 as P from the first which does not pass a fiber previously, and both the polarization S and P is ****ed at this 2nd outgoing-radiation edge 5.

[0009] Although an outgoing radiation is carried out after passing through the inside of the polarization hold optical fiber 11 twice, the outgoing radiation of the S by which incidence was carried out to the above-mentioned beginning at the polarization beam splitter 1 is carried out to P by which incidence was carried out at first at that time with the twice as many optical path difference as the length of a polarization hold optical fiber. Optical fiber length will be good by the length of the half of a required path difference (coherent length) by this.

[0010] While a dielectric film and prism constituted the polarization beam splitter 1 of drawing 1 , as a polarization hold optical fiber 11, using the depolarizer constituted from the panda fiber 50m with a sufficient polarization store property with commercial low loss, incidence of the DFB laser of 100m of coherent length was carried out, and degree of polarization 0.01 was obtained.

[0011] Moreover, drawing 2 shows other examples of a depolarizer according to claim 1, and the same sign is given to the same fraction as drawing 1 . In drawing 2 , although the opticals axis by the side of an outgoing radiation and incidence differ, after P passes through the inside of a polarization hold optical fiber twice, the outgoing radiation of it is carried out by rotating the polarization shaft of the

polarization hold optical fiber 11 by 90 degrees. Also in this configuration, the same degree of polarization as the thing of drawing 1 was obtained.

[0012] Next, the depolarizer using the optical fiber type polarization beam splitter (henceforth a fiber type splitter) according to claim 2 is explained. Although three kinds shown in the following table 1 can be considered, since it is not necessary to take out light to space out of an optical fiber, to a depolarizer here, the thing of all types is usable, and there is an advantage, like a lens system etc. becomes unnecessary in a fiber type splitter common to all these types.

[0013]

[Table 1]

Component x in Table 1 calls it the component of a low group-velocity shaft (x shaft), and component y means the component of a high group-velocity shaft (y-axis).

[0014] The example shown in drawing 3 is a thing using the 1st fiber type splitter 21 in Table 1, the through edge to the 1st incidence edge 24 is the 1st outgoing-radiation edge 26, a cross edge is the 2nd outgoing-radiation edge 27, and, in the 2nd outgoing-radiation edge 27 and a cross edge, the through edge to the 2nd incidence edge 25 turns into the 1st outgoing-radiation edge 26. Although the outgoing radiation of the y component of the polarization by which incidence is carried out to the 1st incidence edge 24 is immediately carried out to the 1st outgoing-radiation edge 26 as y The outgoing radiation of the x component by which incidence is carried out to the 1st incidence edge 24 is carried out to the 2nd outgoing-radiation edge 27 as x, it spreads the optical fiber loop 23 which consists of a polarization hold optical fiber, and incidence is carried out to the 2nd incidence edge 25 as y by the node 22 which rotates polarization by 90 degrees in respect of [arbitrary] this loop 23. The outgoing radiation of this y that carried out incidence to the 2nd incidence edge 25 is carried out to the 2nd outgoing-radiation edge 27 as y, and it spreads the optical fiber loop 23 again, and it carries out incidence to the 2nd incidence edge 25 as x. The outgoing radiation of the x which carried out incidence to the 2nd incidence edge 25 is carried out as x from the 1st outgoing-radiation edge 26.

[0015] When rotated by the node 22 by 90 degrees, after x component which carries out incidence from the 1st incidence edge 24 as mentioned above passes along the optical fiber loop 23 twice, the outgoing radiation of it is carried out, and the same effect as the case where a polarization beam splitter is used is acquired (DEB laser incidence which is 50m of optical fiber loop length, and 100m of coherent length).

[0016] In the example shown in drawing 4 , the through edge of the 1st incidence edge 24 is the 2nd outgoing-radiation edge 27, a cross edge is the 1st outgoing-radiation edge 26, the through edge of the 2nd incidence edge 25 is the 1st outgoing-radiation edge 26, and a cross edge turns into the 2nd outgoing-radiation edge 27. In this example, it is spread to the optical fiber loop 23, and y component by which incidence is carried out to the 1st incidence edge 24 receives retardation, and an outgoing radiation is carried out. However, since x

component is delayed according to the effect of a birefringence between the 1st incidence edge 24 and the 1st outgoing-radiation edge 26 in this case, although there is a possibility that an effect may decrease with some length of the polarization hold optical fiber which constitutes a loop 23, since the effect by the birefringence is the order of 10-3 to 10-4 to polarization hold fiber length, a problem hardly becomes. The almost same result as the depolarizer of a previous example was obtained at the time of close and about 1m of outgoing-radiation fiber length.
[0017] As other examples, what considered the fiber type splitter 21 as the 3rd type of Table 1 with the configuration of drawing 3 is explained. Although the outgoing radiation of the y included in the 1st incidence edge 24 is immediately carried out to the 1st outgoing-radiation edge 26 as y, the outgoing radiation of the x which carried out incidence from the 1st incidence edge 24 is carried out to the 2nd outgoing-radiation edge 27 as y, it spreads the optical fiber loop 23, rotates by 90 degrees in a node 22, and incidence is carried out to the 2nd incidence edge 25 as x. Although the outgoing radiation of the x by which incidence was carried out to the 2nd incidence edge 25 is carried out to the 2nd outgoing-radiation edge 27 as x, it spreads the optical fiber loop 23 again, it rotates by 90 degrees, and carries out incidence to the 2nd incidence edge 25 as y. The outgoing radiation of the y which carried out incidence to the 2nd incidence edge 25 is carried out as x from the 1st outgoing-radiation edge 26. The result equivalent to a previous example was obtained also in the thing of this example.
[0018] Furthermore, the configuration shown in drawing 5 explains the case where a fiber type splitter is considered as the 3rd type of Table 1, as other examples. The relation between the through edge in each close outgoing-radiation edge and a cross edge is the same as that of the example of drawing 4 . Although the outgoing radiation of the x component by which incidence is carried out to the 1st incidence edge 24 is immediately carried out to the 1st outgoing-radiation edge 26 as y, the outgoing radiation of the y included in the 1st incidence edge 24 is carried out to the 2nd outgoing-radiation edge 27 as y, it spreads the optical fiber loop 23 and incidence is carried out to the 2nd incidence edge 25 as y. Especially in this example, the node which rotates polarization by 90 degrees is not prepared in the optical fiber loop 23, but it uses for it that polarization rotates 90 degrees of this function rotated by 90 degrees by the cross edge outgoing radiation of the fiber type splitter 21. As x of the 2nd outgoing-radiation edge 27, the outgoing radiation of the y of the 2nd incidence edge 25 is carried out, it spreads the optical fiber loop 23 again, and incidence is carried out to the 2nd incidence edge 25 as x. The outgoing radiation of the x of the 2nd incidence edge 25 is carried out to the 1st outgoing-radiation edge 26 as x. The same result as a previous example was obtained also in this example.
[0019] (Example 1 of a comparison) coherent using the equipment of the conventional drawing 6 at 50m of optical fiber length -- long -- when incidence of the 100m DFB laser was carried out, the coherent component remains and it was obtained only to about 0.2 degree of polarization
[0020] (Example 2 of a comparison) coherent by the same equipment as the example 1 of a comparison at 100m of optical fiber length -- long -- when incidence of the 100m DFB laser was carried out, it was obtained only to about 0.02 degree of

polarization Each of aforementioned examples and examples of a comparison performs an incident-light intensity, adjusting the polarization orientation of an incident light so that each shaft may become equal.

[0021]

[Effect of the Invention] As explained above, the function to rotate polarization by 90 degrees to the optical fiber loop which consists of a polarization hold optical fiber used as a retardation route is given, and in order only for the light of one component to pass the delay line twice among the polarization components of an incident light by replacing a polarization shaft, delay-line length is made to half conventional]. Therefore, a reduction of a cost is attained, and a fall of the property by aggravation of a cross talk is mitigated, and the loss by fiber propagation can also be reduced, and low loss-ization can be performed collectively.

[Translation done.]

Field

[Field of the Invention] This invention cancels polarization of light and relates to the depolarizer which set the length of the polarization hold optical fiber to use to one half of things same type [conventional] in the depolarizer for suppose-less polarizing.

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Technique

[Description of the Prior Art] Generally the coherence matrix in the status that it does not polarize is [Equation 1].

It is expressed (Doi, "polarization and crystal optics" paragenesis publication). It can be put in another way as each component of 2 polarization shaft having equal ** power, and not doing ** interference of the meaning of this matrix. About equal conditions, incidence of the polarization angle of incidence polarization light can be adjusted and carried out, or power of the above-mentioned ** can be easily realized by carrying out incidence at the angle of 45 degrees [centering around linearly polarized light light] etc. Moreover, it can correspond to arbitrary incident angles by connecting the meantime with the degree of axial angle of 45 degrees using two or more equipments which make the below-mentioned coherence lose like for example, a ********** depolarizer (JOURNAL OF LIGHT WAVETECHNOLOGY Vol LT-1 NO.3 SEPTEMBER 1983).

[0003] ** Produce a time gap between 2 polarization components, and make coherence lose about the conditions of not interfering, by carrying out the gap to more than the coherence time of an incident light. Drawing 5 is explanatory drawing of the conventional equipment, and the sign in drawing 1 is the polarization beam splitter in which the 1st incidence edge 2, the 2nd incidence edge 3, the 1st outgoing-radiation edge 4, and the 2nd outgoing-radiation edge 5 were established. The polarization by which incidence was carried out from the 1st incidence edge 2 consists of a P polarization component (henceforth P) which goes straight on at the 2nd outgoing-radiation edge 5, and an S polarization component (henceforth S) which is separated and is led to the 1st outgoing-radiation edge 4. Among P and S which carried out incidence from the 1st incidence edge 2, P goes straight on, an outgoing radiation is immediately carried out from the 2nd outgoing-radiation edge 5, after dissociating, from the 1st outgoing-radiation edge 4, it goes into a polarization beam splitter 1 again, and is reflected through the polarization hold optical fiber 6, and the outgoing radiation of the S is carried out from the 2nd outgoing-radiation edge 5 with P which goes straight on. Thus, a polarization beam splitter 1 separates into S and P, and coherence is made to lose by carrying out the optical path difference during both polarization to more than coherent length (coherent time x velocity of light) by passing the polarization hold optical fiber 6 which serves as the delay line only in S.

[0004] Coherence-length deltaL will serve as C/delta f in general here, if half-value width of the spectrum of C and the light source is set to deltaf for the velocity of light. For example, in the with a half-value width [of about 1MHz] light sources (for example, DFB laser etc.), coherent length becomes 100m order. If it is going to acquire this optical path difference only by the birefringence of an optical fiber like

an above-mentioned ********** depolarizer, it becomes 5x10-4, then several 100km order about the average birefringence value of the present polarization hold optical fiber, a property deteriorates by the cross talk of an optical fiber, loss, etc., and it is not practical.

Effect

[Effect of the Invention] As explained above, the function to rotate polarization by 90 degrees to the optical fiber loop which consists of a polarization hold optical fiber used as a retardation route is given, and in order only for the light of one component to pass the delay line twice among the polarization components of an incident light by replacing a polarization shaft, delay-line length is made to half conventional]. Therefore, a reduction of a cost is attained, and a fall of the property by aggravation of a cross talk is mitigated, and the loss by fiber propagation can also be reduced, and low loss-ization can be performed collectively.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] By the way, if the thing using the conventional polarization beam splitter also serves as several 100m order, compared with a usual optical fiber, (a) polarization hold optical fiber will be expensive, and will serve as cost quantity.
(b) In order that the influence of a cross talk may come out, the need of being made not to apply the external stress which worsens a cross talk in consideration of covering of an optical fiber, the fixed technique of an optical fiber, etc. arises.
(c) It becomes impossible to ignore the loss in an optical fiber.
The fault of a grade appears. Therefore, although the length of a polarization hold optical fiber had the shorter good one, in order to secure coherent length, it was not made short.
[0006] For this invention, the fiber length which uses it in the depolarizer for were made in view of the above-mentioned situation, cancel polarization of light, and suppose-less polarizing is one half to a thing same type [conventional]. It aims at offering the depolarizer which can be shortened.

[Translation done.]

MEANS

[Means for Solving the Problem] In the depolarizer concerning this invention The 1st and the 2nd incidence edge, The polarization beam splitter which has the 1st and 2nd outgoing-radiation edges, divides into S polarization component and P polarization component the polarization by which incidence was carried out from the 1st incidence edge, and carries out an outgoing radiation from the 1st outgoing-radiation edge and the 2nd outgoing-radiation edge, respectively, the of this polarization beam splitter / the 1st or] -- an end is connected to 2 outgoing-radiation edge, the other end rotates 90 degrees of the polarization shaft, and it connects with the incidence edge of the above 2nd, and made into the means of a problem solving to consist of a polarization hold optical fiber which functions as delay line Or it has the 1st and 2nd incidence edges and the 1st and 2nd outgoing-radiation edges. The optical fiber type polarization beam splitter which consists of a polarization hold optical fiber which carries out an outgoing

radiation to the outgoing-radiation edge which divides into a high group-velocity shaft component and a low group-velocity shaft component the polarization by which incidence was carried out, and is respectively different from each incidence edge, An end is connected to one outgoing-radiation edge of this optical fiber type polarization beam splitter. It consists of a polarization hold optical fiber which constitutes an optical fiber loop with the above-mentioned optical fiber type polarization beam splitter while it connects with one incidence edge and the other end functions as delay line. The depolarizer in which the fraction which has the function to rotate a polarization shaft by 90 degrees in the above-mentioned optical fiber loop exists is sufficient.

[Translation done.]

EXAMPLE

[Example] Drawing 1 gives the same sign to the same component as what shows an example of a depolarizer according to claim 1, and was shown in drawing 5 , and omits the explanation. If two polarization, P polarization, and S polarization included in a polarization beam splitter 1 carry out incidence from the 1st incidence edge 2 The outgoing radiation of the P which goes straight on is immediately carried out from the 2nd outgoing-radiation edge 5, incidence of the S is carried out to the polarization hold optical fiber 11 which makes an optical fiber loop from the separated back 1st outgoing-radiation edge 4, it spreads the inside of an optical fiber, and rotates by 90 degrees, and incidence is carried out to a polarization beam splitter 1 from the 2nd incidence edge 3 as P. The angle which the amount of [in this invention] 90 degrees are because the same effect is acquired if angle of rotation is 90 degrees +nx180 degrees (however, n integer) in addition to 90 degrees, and can acquire such an effect is named generically. Since it goes the inside of a polarization beam splitter 1 straight on, after propagation, incidence is again carried out to the polarization hold optical fiber 11 from the 1st incidence edge 3, P rotates by 90 degrees, as S, the outgoing radiation of it is carried out and incidence is carried out to a polarization beam splitter 1. The outgoing radiation of this S is carried out in the orientation of the 2nd same outgoing-radiation edge 5 as P from the first which does not pass a fiber

previously, and both the polarization S and P is ****ed at this 2nd outgoing-radiation edge 5.

[0009] Although an outgoing radiation is carried out after passing through the inside of the polarization hold optical fiber 11 twice, the outgoing radiation of the S by which incidence was carried out to the above-mentioned beginning at the polarization beam splitter 1 is carried out to P by which incidence was carried out at first at that time with the twice as many optical path difference as the length of a polarization hold optical fiber. Optical fiber length will be good by the length of the half of a required path difference (coherent length) by this.

[0010] While a dielectric film and prism constituted the polarization beam splitter 1 of drawing 1 , as a polarization hold optical fiber 11, using the depolarizer constituted from the panda fiber 50m with a sufficient polarization store property with commercial low loss, incidence of the DFB laser of 100m of coherent length was carried out, and degree of polarization 0.01 was obtained.

[0011] Moreover, drawing 2 shows other examples of a depolarizer according to claim 1, and the same sign is given to the same fraction as drawing 1 . In drawing 2 , although the opticals axis by the side of an outgoing radiation and incidence differ, after P passes through the inside of a polarization hold optical fiber twice, the outgoing radiation of it is carried out by rotating the polarization shaft of the polarization hold optical fiber 11 by 90 degrees. Also in this configuration, the same degree of polarization as the thing of drawing 1 was obtained.

[0012] Next, the depolarizer using the optical fiber type polarization beam splitter (henceforth a fiber type splitter) according to claim 2 is explained. Although three kinds shown in the following table 1 can be considered, since it is not necessary to take out light to space out of an optical fiber, to a depolarizer here, the thing of all types is usable, and there is an advantage, like a lens system etc. becomes unnecessary in a fiber type splitter common to all these types.

[0013]

[Table 1]

Component x in Table 1 calls it the component of a low group-velocity shaft (x shaft), and component y means the component of a high group-velocity shaft (y-axis).

[0014] The example shown in drawing 3 is a thing using the 1st fiber type splitter 21 in Table 1, the through edge to the 1st incidence edge 24 is the 1st outgoing-radiation edge 26, a cross edge is the 2nd outgoing-radiation edge 27, and, in the 2nd outgoing-radiation edge 27 and a cross edge, the through edge to the 2nd incidence edge 25 turns into the 1st outgoing-radiation edge 26. Although the outgoing radiation of the y component of the polarization by which incidence is carried out to the 1st incidence edge 24 is immediately carried out to the 1st outgoing-radiation edge 26 as y The outgoing radiation of the x component by which incidence is carried out to the 1st incidence edge 24 is carried out to the 2nd outgoing-radiation edge 27 as x, it spreads the optical fiber loop 23 which consists of a polarization hold optical fiber, and incidence is carried out to the 2nd incidence edge 25 as y by the node 22 which rotates polarization by 90 degrees in

respect of [arbitrary] this loop 23. The outgoing radiation of this y that carried out incidence to the 2nd incidence edge 25 is carried out to the 2nd outgoing-radiation edge 27 as y, and it spreads the optical fiber loop 23 again, and it carries out incidence to the 2nd incidence edge 25 as x. The outgoing radiation of the x which carried out incidence to the 2nd incidence edge 25 is carried out as x from the 1st outgoing-radiation edge 26.

[0015] When rotated by the node 22 by 90 degrees, after x component which carries out incidence from the 1st incidence edge 24 as mentioned above passes along the optical fiber loop 23 twice, the outgoing radiation of it is carried out, and the same effect as the case where a polarization beam splitter is used is acquired (DEB laser incidence which is 50m of optical fiber loop length, and 100m of coherent length).

[0016] In the example shown in drawing 4 , the through edge of the 1st incidence edge 24 is the 2nd outgoing-radiation edge 27, a cross edge is the 1st outgoing-radiation edge 26, the through edge of the 2nd incidence edge 25 is the 1st outgoing-radiation edge 26, and a cross edge turns into the 2nd outgoing-radiation edge 27. In this example, it is spread to the optical fiber loop 23, and y component by which incidence is carried out to the 1st incidence edge 24 receives retardation, and an outgoing radiation is carried out. However, since x component is delayed according to the effect of a birefringence between the 1st incidence edge 24 and the 1st outgoing-radiation edge 26 in this case, although there is a possibility that an effect may decrease with some length of the polarization hold optical fiber which constitutes a loop 23, since the effect by the birefringence is the order of 10-3 to 10-4 to polarization hold fiber length, a problem hardly becomes. The almost same result as the depolarizer of a previous example was obtained at the time of close and about 1m of outgoing-radiation fiber length.

[0017] As other examples, what considered the fiber type splitter 21 as the 3rd type of Table 1 with the configuration of drawing 3 is explained. Although the outgoing radiation of the y included in the 1st incidence edge 24 is immediately carried out to the 1st outgoing-radiation edge 26 as y, the outgoing radiation of the x which carried out incidence from the 1st incidence edge 24 is carried out to the 2nd outgoing-radiation edge 27 as y, it spreads the optical fiber loop 23, rotates by 90 degrees in a node 22, and incidence is carried out to the 2nd incidence edge 25 as x. Although the outgoing radiation of the x by which incidence was carried out to the 2nd incidence edge 25 is carried out to the 2nd outgoing-radiation edge 27 as x, it spreads the optical fiber loop 23 again, it rotates by 90 degrees, and carries out incidence to the 2nd incidence edge 25 as y. The outgoing radiation of the y which carried out incidence to the 2nd incidence edge 25 is carried out as x from the 1st outgoing-radiation edge 26. The result equivalent to a previous example was obtained also in the thing of this example.

[0018] Furthermore, the configuration shown in drawing 5 explains the case where a fiber type splitter is considered as the 3rd type of Table 1, as other examples. The relation between the through edge in each close outgoing-radiation edge and a cross edge is the same as that of the example of drawing 4 . Although the outgoing radiation of the x component by which incidence is carried out to the 1st incidence edge 24 is immediately carried out to the 1st outgoing-radiation edge 26

as y, the outgoing radiation of the y included in the 1st incidence edge 24 is carried out to the 2nd outgoing-radiation edge 27 as y, it spreads the optical fiber loop 23 and incidence is carried out to the 2nd incidence edge 25 as y. Especially in this example, the node which rotates polarization by 90 degrees is not prepared in the optical fiber loop 23, but it uses for it that polarization rotates 90 degrees of this function rotated by 90 degrees by the cross edge outgoing radiation of the fiber type splitter 21. As x of the 2nd outgoing-radiation edge 27, the outgoing radiation of the y of the 2nd incidence edge 25 is carried out, it spreads the optical fiber loop 23 again, and incidence is carried out to the 2nd incidence edge 25 as x. The outgoing radiation of the x of the 2nd incidence edge 25 is carried out to the 1st outgoing-radiation edge 26 as x. The same result as a previous example was obtained also in this example.
[0019] (Example 1 of a comparison) coherent using the equipment of the conventional drawing 6 at 50m of optical fiber length -- long -- when incidence of the 100m DFB laser was carried out, the coherent component remains and it was obtained only to about 0.2 degree of polarization
[0020] (Example 2 of a comparison) coherent by the same equipment as the example 1 of a comparison at 100m of optical fiber length -- long -- when incidence of the 100m DFB laser was carried out, it was obtained only to about 0.02 degree of polarization Each of aforementioned examples and examples of a comparison performs an incident-light intensity, adjusting the polarization orientation of an incident light so that each shaft may become equal.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is drawing showing one example of the depolarizer concerning this invention using the polarization beam splitter.
[Drawing 2] It is drawing showing other examples using the polarization beam splitter.
[Drawing 3] It is drawing showing one example of this invention using the coupler type beam splitter.

[Drawing 4] It is drawing showing other examples using the optical fiber type beam splitter.
[Drawing 5] It is drawing showing other examples using the optical fiber type polarization beam splitter.
[Drawing 6] It is drawing showing the conventional depolarizer.
[Description of Notations]
1 [-- The 2nd incidence edge,] -- A polarization beam splitter, 2 -- The 1st incidence edge, 3 4 [-- A polarization hold optical fiber, the polarization hold optical fiber which makes it rotate by 11--90 degrees,] -- The 1st outgoing-radiation edge, 5 -- The 2nd outgoing-radiation edge, 6 21 [-- An optical fiber loop, 24 / -- The 1st incidence edge, 25 / -- The 2nd incidence edge, 26 / -- The 1st outgoing-radiation edge, 27 / -- The 2nd outgoing-radiation edge, P, S / -- A polarization component, x y / -- Polarization component] -- An optical fiber coupler type polarization beam splitter (coupler type splitter), 22 -- A node, 23

[Translation done.]

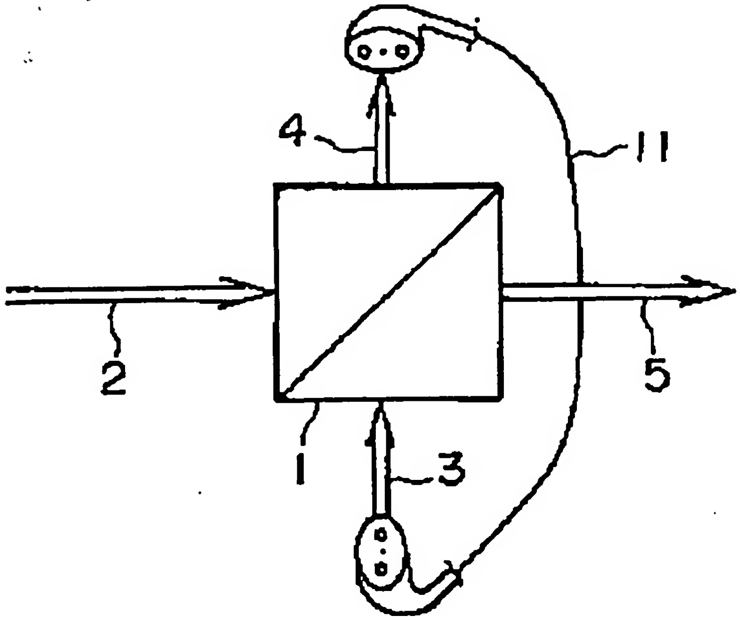

Image 1

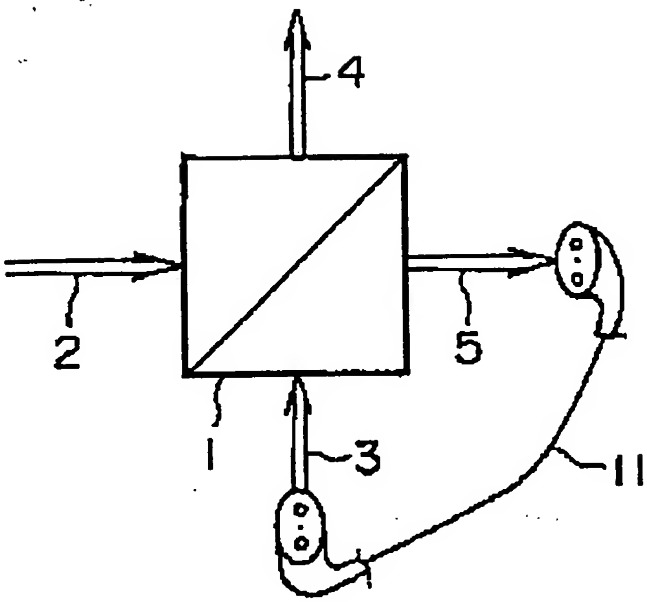

Image 2

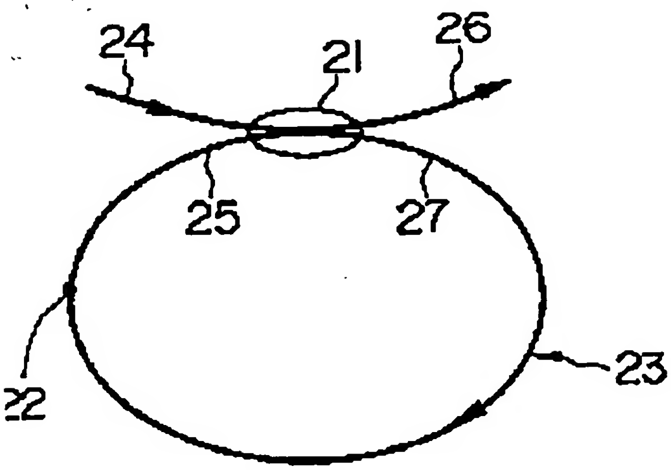

Image 3

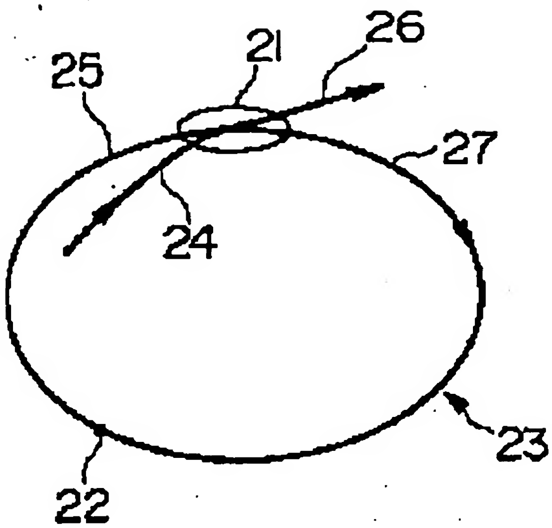

Image 4

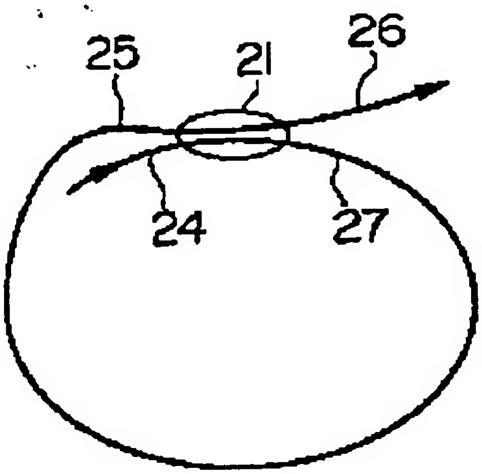

Image 5

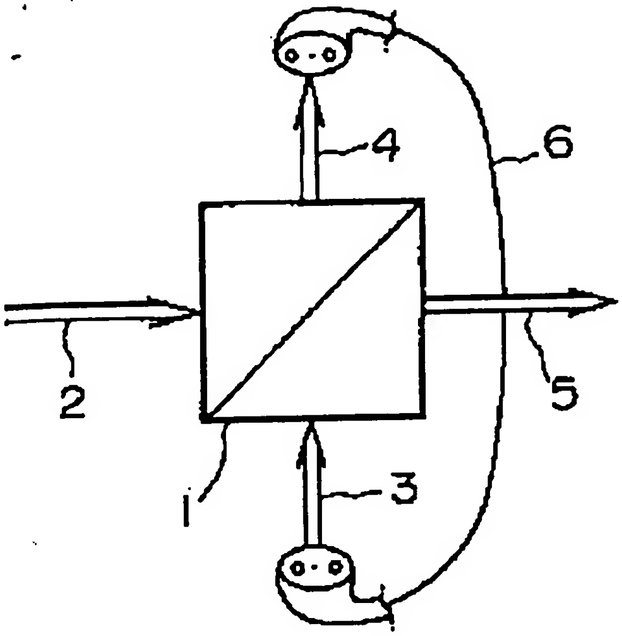

Image 6